

Senn (E. J.)

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TRAUMATIC RUPTURE OF THE URETHRA.¹

BY EMANUEL J. SENN, M.D.,
of Chicago, Ill.

Associate in Surgery, Rush Medical College, in affiliation with the University of Chicago; Assistant Surgeon, Presbyterian Hospital; Assistant Surgeon St. Joseph's Hospital, Chicago.

THIS subject is one of vital importance in the realm of surgery, as it belongs to the department of emergency work. It, therefore, not only concerns the surgeon, but more particularly the general practitioner who is called upon for prompt judgment and decisive action in order to save life. It is strange but nevertheless true that most authors on operative surgery deal in great detail with subjects of minor consequence and pass this great and important subject with a few remarks.

Ruptures of the urethra have been classified according to Terrillon into (1) interstitial (first degree); (2) rupture of the mucosa and submucosa (second degree); (3) rupture of the urethra through its entire thickness, either complete or incomplete (third degree). This classification is irrational, as it is often difficult to make a diagnosis according to this plan at the time of injury; except in the interstitial variety. We could only rely as a general rule on this classification after a perineal section or better after an autopsy. The best classification from a clinical and practical standpoint is that of Max Oberst into (1) partial rupture of the urethra without destroying its continuity; (2) complete rupture of the urethra, entirely destroying its continuity.

According to Oberst the mechanism of urethral injuries is generally thus: With the limbs spread the patient falls against some object which strikes the perineum. The perineum and urethra are thrown against

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the symphysis pubis with great force. As the urethra is bound to the symphysis by the pubo-prostatic ligament, it is impossible to avoid impact against the lower border of the symphysis; or if the blow is more lateral, the urethra is crushed against the descending ramus of the pubis. The overlying skin, which is more elastic, usually remains intact. Oberst's ideas have been fully verified by the experiments of Terrillon. He suspended cadavers by the neck with a rope leading over a pulley. An object was placed underneath the subject in the axis of the perineum. The body was let fall suddenly, the perineum striking the object; the head and trunk inclining forward, producing in this manner rupture of the deep urethra.

Terrillon comes to the conclusion that if the trauma is produced by falling astride upon a narrow body, rupture is produced by crushing the urethra against the ischiopubic rami. If the body is large enough to fill the pubic arch, the urethra is crushed against the anterior surface of the pubis. These experiments, although ingenious and convincing, do not give positive evidence, as in the cadaver circumstances cannot be compared with the living. In the dead body the tissues are flabby and not defended by the muscles of the perineum, nor protected by the resilient living tissues. Again there is entire absence of instinctive resistance.

Moreover, as Gayet has remarked, the body tends to swing to either side, and the object is apt to strike the internal aspect of the thigh, instead of the perineum over the middle line. The membranous portion is usually spared in experimental contusions, while it is more vulnerable to accidental injuries, especially kicks from behind when the body is inclined forward. Poncet and Ollier claim that not all ruptures are due to impact against the pubis. They insist that the force is directed against the triangular ligament, which cuts the upper wall of the urethra. They performed experiments by placing bougies of soft wax in the

urethra and then striking the perineum with force. There remained an impression in the wax, corresponding well with the ligament. They state that this only applied to the membranous portion and that rupture of the bulbous segment is produced by pressure against the pubis. Terrillon and Emile Forgue have repeated the experiments, but never found the bougie notched. Forgue has no faith in Ollier and Poncet's theory, nor the practical point which such a theory would warrant, that is, passing the sound along the posterior wall in these injuries. Kauffman gives the statistics of the cause of rupture of the urethra in 239 cases as follows: 198, or 82%, were due to injuries à califourchon, that is, falling astride of some object; 28, or 12%, due to a blow upon the perineum; 9, or 4%, caused by being thrown upon the pommel of a saddle. There is no doubt that injuries à califourchon are the most frequent cause of rupture. In fractures of the pelvis, especially of the pubic portion, the deep urethra is almost invariably torn, or voiding of urine is interfered with by pressure upon the urethral canal. Rose, in 10 cases, found that interference with urination remained free only in one case.

In fractures of the pelvic ring, the deep urethra, with the exception of the prostatic portion, is especially prone to be injured on account of its fixed position by means of the triangular ligament. Gosselin believes that fractures of the pelvis usually cause partial rupture. In all of Oberst's observations of such injuries the urethra was completely ruptured. Sometimes, as observed by Durand, there is rupture before the fracture actually occurs. This is most likely when the force is applied upon the perineum. In dislocation of the pubis, there is overlapping of the bones, and rupture of the urethra results, on account of traction on the triangular ligament. In severe contusions of the pelvis there may be rupture by reason of momentary dislocation of the symphysis. A few cases have been reported

due to muscular action, caused by exaggerated adduction of the thigh. There may be partial rupture due to violent instrumentation. This is very likely to occur in dilatation of strictures of the nonresilient variety, and is most liable to happen in the bulbomembranous region. Even in careful manipulation how readily hemorrhage follows, and it can be easily understood how an interstitial rupture could be a sequence of any forced effort at dilatation.

Injuries of the pars pendula are rare, being due to direct force or violent coition. They may come as complications of rupture of the corpora cavernosa, the so-called fracture of the penis (Hyrtle) or pseudo-fracture (Demarquay). The flaccidity and mobility of the penis are protections against injury. When injured, it is usually in a state of erection, although Voillemier and James Madden each report a case in which the penile portion was injured by a kick when in a flaccid state.

It is difficult to locate the exact seat of the injury with precision on account of the varying length of the urethra, the destruction and alteration of the position of the tissue by reason of blood-clots and infiltration of urine. Most authors do not report the exact location. Paoli, Socin, and Fontan report cases due to injuries à califourchon in which the trauma was in the membranous portion. This subject has been given very thorough study by both Cras and Terrillon. The harvest of their research has been due to autopsies, experimental research and observations after perineal section for this injury. Cras claims the bulbous portion to be invariably the seat of injury. This is disputed by Guyon, who, while admitting that the bulbous portion is the most frequently injured, believes that the other portions are frequently involved. Terrillon described 9 cases, 6 of the bulb and 3 of the membranous portion. Kauffmann mentions a case of König in which there was a tear of both the bulb and membranous portion; also a case of Bourgeois in which the membranous

urethra was alone involved. Oberst reported 5 autopsies, 4 of the membranous portion and only 1 of the bulb. Oberst makes a general broad differentiation (1) ruptures of the pars membranacea; (2) ruptures in the neighborhood of the neck of the bladder. To locate the seat of rupture with exact anatomic precision is often impossible as well as unimportant. The rule of Oberst in determining the seat of injury is approximate enough for the requisite surgical treatment.

The diagnosis of injury of the urethra is not difficult, but to arrive at definite conclusions as regards the extent of damage is another matter. Rupture is heralded by hemorrhage from the meatus. This may be a few drops to a continuous flow of bright-red blood. The quantity of hemorrhage is no criterion whatever as to the severity of the injury. The artery of the bulb might be lacerated by a slight rupture and the hemorrhage would be very profuse; while on the other hand there might be a complete rupture, including the paraurethral tissues, followed by little hemorrhage. The urethral walls possess great elasticity and retract after being severed. The interim between the cut ends becomes occluded with a coagulum, in which instance the flow from the meatus would be scanty.

In complete rupture there is immediate interference with urination, but in partial rupture micturition may not be at first interfered with, but later there is complete occlusion, due to paraurethral infiltration. In the interstitial variety, there is difficulty of micturition, due to infiltration of the urethral wall and in that manner causing a temporary stoppage of the urethra. In three-fourths of all cases there is retention of urine due to coagula. Swelling of the perineum and scrotum results from a blood-clot in the paraurethral tissues, or extravasation of urine. A swelling immediately following an injury is from blood. A gradual progressive swelling coming on some time after receipt of the injury is due to extravasation of urine.

The membranous urethra is badly protected. It is invested by a very thin plane of muscle-tissue, the compressor urethræ muscle. It is not supported by the tissues of the perineum, being simply suspended by the two layers of the triangular ligament. The origin of these is from the symphysis, after which they diverge gradually until the level at which they are pierced by the urethra, where they are about one inch apart. From this point downward, they converge and are inserted in the median raphe of the perineum. When the membranous portion alone is injured, there is extravasation into the cavity of the triangular ligament. Extravasation of urine cannot extend beyond the rami of the pubis and ischium without rupture of the anterior or posterior layer. In such cases a swelling is detected in the middle line of the perineum. When the rupture occurs in front of the triangular ligament there is enormous infiltration of the scrotum, and in neglected cases the edema proceeds up the abdomen towards the umbilicus and down the inner aspect of the thighs. There is usually pain at the seat of injury, which is increased in attempts at urination. Escape of urine in the tissues, if not dealt with by proper surgical interference, is followed by infection, abscess-formation, and septicemia.

Normal urine in a healthy bladder is aseptic. According to Lehmann and Richter, it is even antiseptic; but after it has left the genitourinary tract, it decomposes and causes toxic symptoms.

In severe cases we may say with Guyon that the cardinal symptoms are (1) complete retention; (2) copious and continual urethrorrhagia; (3) large perineal swelling. All injuries of the urethra, irrespective of accompanying complications, such as fractures of the pelvis, etc., must be considered with great apprehension, on account of the great liability of infection in this region. The prognosis in partial rupture is favorable as compared with complete rupture; especially is this the case

in the so-called interstitial variety of Terrillon. Kauffmann, in unselected cases, places the mortality at 14%. As soon as a diagnosis has been made, catheterization affords an efficient and conservative measure to combat the most important indication, that is, retention.

In partial rupture, catheterization is often successful; in the complete variety it is seldom, if ever, attended with success, but serves as a means of diagnosis. A soft Nelaton catheter, well lubricated, or, better, preceded by an injection of olive-oil or glycerin, is carefully inserted and manipulated in an attempt to pass the obstruction. If this be unsuccessful, an effort may be made with a metallic catheter, as clots are more easily displaced, and entrance into the bladder thus facilitated. The metallic catheter is a dangerous instrument in the healthy urethra if handled by unskilled hands, and in the torn urethra is treacherous even in skilled hands. It should be allowed to find its way principally through its own weight. In catheterization it should be remembered that in the great majority of cases the wound is in the posterior wall, in the region of the bulb; therefore, follow the anterior wall when there is the greatest likelihood of a portion of the urethra remaining intact to serve as a guide. The anterior wall has been well named by Guyon the "surgical wall." If there is doubt as to whether the bulbous or membranous urethra is torn, it is advisable to follow the anterior wall in the bulbous portion, and the posterior wall in the membranous urethra, as here the anterior wall is most frequently injured. If successful, allow the catheter to remain several days, as advised by Duplay. Kauffmann rejects this treatment. He claims a mortality of 13% when the catheter was retained, due to infiltration and abscesses at the seat of injury around the catheter. This great mortality can, in all probability, be greatly diminished in the future by frequent irrigation of the bladder.

Suprapubic puncture has had its day. It can only

be recommended in extreme distention of the bladder. In itself it is a harmless operation and has been done repeatedly on the same patient. It fulfilled its mission in the preantiseptic age when both catheterization and perineal section were so often fatal. This measure was highly lauded by Orlowski and recommended by the French surgeons Civiale, Phillips and Gosselin in cases in which urine-infiltration had not as yet taken place. Böckel, Güterbock, Hüter, König, Neuber Nota, and Reybard allow puncture as a palliative means for draining the bladder, but insist that a restoration of the urethra by an external urethrotomy is still necessary. This form of treatment is only permissible for temporary relief of a distended bladder. The mortality of systematic suprapubic puncture is 19%.

In severe cases prompt perineal section is the logical treatment. In all cases in which catheterization is impossible, there is no other worthy procedure. When catheterization is possible, but there is a partial rupture of all the coats of the urethra, perineal section is safer than assuming the risks of infection at the seat of rupture resulting in abscess-formation.

Perineal section was done by Chopart, Desault, and Lallemand, in the beginning of the century, and is confirmed at the present time by Cras, Guyon, and Terrillon. As compared with the other methods of treatment it presents the lowest mortality, this being only 8.75%. It fulfils all the indications. Not only can the seat of injury itself receive the requisite surgical treatment, but, what is far more important, drainage is insured. Blood-clots can be removed, and if the case has proceeded to the point of suppuration, neighboring abscesses can be summarily dealt with. In complete rupture it is often a tedious and difficult task to find the proximal end, as there is retraction of the severed ends to the extent of an inch or two. Again, it is difficult to identify the urethra from the surrounding tissues on account of the bruised condition of the parts.

Moreover, there is apt to be displacement by reason of blood-clots and extravasated urine. It has been advised to make pressure in the vesical region with the hope of causing exudation of a few drops of urine from the proximal end. This is very often unsuccessful because of a coagulum in the lumen of the urethra or a retraction of the cut end. In complete rupture it is generally the membranous portion which is concerned, and here the compressor urethrae is an important factor in thwarting such attempts. Fenger suggests that if a reasonable search for the proximal end is not crowned with success, to pack the perineal wound with an antiseptic dressing, aspirate the bladder and await developments. However, such a course appears fallacious. Procrastination is dangerous; although the patient is better off than relying on aspiration alone, as drainage is provided for and extravasation into the surrounding tissues is prevented; but it does not preclude the danger of toxic absorption.

When the proximal end of the urethra cannot be located, suprapubic cystotomy should be performed without hesitation, followed by retrograde catheterization. The operation is performed with little risk to life, the enormous distention of the bladder making an extraperitoneal incision much less difficult than under other circumstances.

The first case reported in literature was operated upon by Dr. Daniel Brainard, of Chicago, in 1848. However, the operation was done for impassable stricture. He punctured the bladder with a curved trocar, which was left in situ. Eight weeks later a bougie was passed from the bladder through the stricture. Volkmann claimed to be the originator of this technic in a case operated upon by him years afterward. Ranke performed retrograde catheterization through a trocar opening in the bladder, like Brainard.

Retrograde catheterization has its field of usefulness in desperate cases, as is verified by not a few successful

cases in which it was resorted to, both for traumatic rupture and impermeable stricture.

Recently I had an interesting case of injury of the urethra under my care, in which I was forced to do posterior catheterization, and of which I will give a brief history:

Mr. C. A., aged 30, September 17, 1898, fell astride a box. After the injury, he experienced pain in the perineal region, hemorrhage occurred from the meatus, and micturition was impossible. He consulted his family-physician, who, after considerable manipulation, was able to pass a metallic catheter. After emptying the bladder the catheter was withdrawn. In the course of a few hours the bladder became greatly distended. Catheterization was again attempted, but proved fruitless. I then saw the patient in consultation.

I found the bladder distended almost to the umbilicus and the patient in great pain. There was no extravasation of urine, but perineal bulging due to a blood-clot. The inner aspect of the thighs presented several areas of ecchymosis, denoting that the object struck was large. The temperature was 99.6° and the pulse 100. I tried to pass a Nelaton catheter, but without success, meeting an obstruction in the neighborhood of the bulb. A perineal section was advised and the patient entered St. Joseph's Hospital.

I passed a staff into the urethra up to the obstruction and then made an incision into the bulbous urethra where I found the distal end and a large blood-clot. The tissues were greatly bruised.

Then began a wearisome search for the proximal end with a small probe. I could find no vestige of mucous membrane in a proximal direction. Manual pressure over the bladder failed to expel any urine. Retrograde catheterization presented the only prospect. The suprapubic region was disinfected and cystotomy performed. The index finger was introduced into the bladder and the vesical orifice of the urethra found. A flexible bougie was passed through the proximal urethra into the perineal wound. A large Nelaton catheter was attached and drawn into the bladder. A silk cord was tied to the proximal end of the catheter, brought out of the suprapubic wound and secured externally with an adhesive strip in order to master the catheter in the future. The distal end of the catheter was next placed in the penile portion of the urethra. The suprapubic wound was drained by a rubber tube, so that there was uninterrupted drainage from the suprapubic opening to the meatus. The perineal wound was packed with gauze. The patient was given salol and put on a light diet. After several days the tube in the suprapubic wound was removed and gauze drainage substituted. The catheter was allowed to remain. The bladder was irrigated daily with a solution of boric acid.

The patient was fast progressing to recovery when, about two weeks after the operation, he was suddenly seized with a chill followed by a temperature of 105.4°, and a pulse of 110. The bladder was at once irrigated and this was continued every 3 hours. A tube was reinserted in the bladder wound. Large doses of quinin were administered. Bacteriologic examination of the urine showed streptococci and the bacillus coli communis to be the cause of the cystitis. All the symptoms of a violent cystitis continued for 10 days, when they abated and the patient rapidly recovered.

The unfortunate secondary infection detracted somewhat from the success of this case, but had no bearing on the technic of the operation. After leaving the hospital, the family-physician passed a steel sound several times, but since that time there was no further dilatation. I have kept track of the patient since, but the stream of urine voided has never become diminished in size. I attribute the remote good result to the fact that the catheter à permanence was allowed to remain in situ such a continued length of time (20 days). The many cases of stricture following traumatic rupture are due to the too early removal of the catheter. Most works on surgery only advise 5 or 6 days.

In recent years urethral wounds have often been repaired by primary suture. Kauffmann and, after him, Hägler have demonstrated experimentally that primary suture is not followed by cicatricial contraction. Hägler, in one of his experiments, cut the urethra through its whole circumference. He then united the two ends with catgut sutures which incorporated the entire thickness of the urethral wall. The external wound was closed except at the lower angle. No catheter was left in place. In 9 days the wound was cicatrized and micturition normal. Two months later the animal was killed. The urethra was found in a normal condition, no cicatrix being visible. He strongly urges suture of the urethra itself, or juxtaurethral suturing with catgut, together with closure of the external wound, as the best means to prevent subsequent stricture.

Nogues collected 19 cases of rupture, in which the

urethra was sutured with satisfactory results. Manley, Pearce Gould, Boisson, Rudolph Frank, and Delorme have reported successful cases. Delorme's case was done two months after injury. There was a space of 2 centimeters between the ruptured ends, filled with fungous granulations. These were removed with a curet, the ends vivified and sutured. The condition of the patient is reported as satisfactory four months later.

On the other hand, G. Baring, of Birmingham, reports 3 cases in which immediate suturing did not result satisfactorily. Primary suture appeals to the thinking surgeon.

However, taking into consideration the most frequent cause of rupture of the urethra, it is evident that the great majority of such wounds are contused and not incised wounds. Contused wounds are unfavorable for primary healing on account of the disorganization of the tissues. Kauffmann's and Hägler's experiments give very little convincing evidence in favor of this operation, as they produced incised wounds which are favorable to definitive healing. The success of the other cases recorded would probably have been as good if treated by perineal section alone; provided a catheter were left in the urethra a requisite length of time. Cicatricial contraction in this locality is very prone to occur if the urethral walls are allowed to collapse.

Le Fort found the urethra occluded 24 days after accident. Quenn found the same condition in 3 weeks. His case was a mild injury à califourchon. The patient at the time of injury passed only a few drops of blood, had slight dysuria and no perineal swelling.

In incised wounds primary suture should be the rule, but in contused wounds a few paraurethral sutures should be inserted, merely to prevent retraction of the severed ends. The perineal opening should never be entirely sutured, as free drainage cannot be dispensed with without direful results.